NANO-MASTER, Inc

Plasma Enhanced Atomic Layer Deposition (PEALD) and Plasma Enhanced Chemical Vapor Deposition (PECVD) hybrid system

Plasma Enhanced Chemical Vapor Deposition (PECVD) and Plasma Enhanced Atomic Layer Deposition (PEALD) are both plasma-assisted thin film deposition techniques widely used in semiconductor manufacturing. PECVD relies on continuous gas-phase reactions activated by a plasma to deposit films at relatively low substrate temperatures, making it ideal for fast deposition of materials such as SiO_2, Si_3N_4, or amorphous carbon. In contrast, PEALD employs sequential, self-limiting surface reactions, enhanced by plasma activation, to deposit conformal ultra-thin films with atomic-scale thickness control and superior uniformity over complex topographies. While PECVD offers high throughput and thicker layers, PEALD is preferred for critical layers requiring precision and conformality, such as high-κ dielectrics or barrier layers.

Nano-Master has developed and patented an innovative hybrid reactor design that seamlessly integrates Plasma Enhanced Atomic Layer Deposition (PEALD) and Plasma Enhanced Chemical Vapor Deposition (PECVD) processes within a single chamber. ALD is done with a separated plasma and ALD volume and PECVD is done by producing plasma in the ALD volume after number of ALD layers have been put. Integrating both techniques in a single chamber enables highly efficient processing of multilayer stacks, interface engineering, and in-situ surface preparation without vacuum breaks—essential for advanced device fabrication where both film quality and production efficiency are critical.

Key components and functionality

- **Shared RF power source**: Utilizes a common RF power supply for both PEALD and PECVD operations, streamlining the hardware requirements.
- **Electrically controlled RF switch**: Enables rapid switching between PEALD and PECVD modes by directing RF power to the appropriate components.
- **Inductively Coupled Plasma (ICP) source**: Employed during PEALD mode to generate plasma above a grounded metal plate, facilitating uniform thin-film deposition.
- **RF-Powered metal plate**: In PECVD mode, the metal plate itself is energized to produce plasma around the substrate, enabling efficient film growth.
- **Heated platen with RF bias**: Applies a low-frequency RF bias (300–450 kHz) to the substrate holder during PECVD to manage film stress and improve adhesion.

Advantages

- **Seamless mode transition**: The hybrid design allows for quick and contamination-free software switching between PEALD and PECVD processes, eliminating the need for separate chambers or transferring wafers.
- **Cost efficiency**: By sharing key components and reducing hardware complexity, the system lowers capital and operational expenditures. Two systems in one footprint
- **Enhanced film quality**: The ability to perform PEALD and PECVD in succession without vacuum breaks improves interface quality and film conformity.
- **Process flexibility**: Supports the deposition of complex multilayer structures and enables in-situ surface treatments, expanding the range of achievable film properties.

Applications

- Metallization and Gate Stack
- GaN G-HEMT Transistor
- Supercapacitor
- Power Electronics
- Gas Permeation Barrier

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